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AUTHOR Desforges, Charles
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ABSTRACT

Educational research is distinctive inasmuch as it shares the moral objective of education, which is to help people make the best of themselves through processes of learning. Educational research is a service industry for education. As such, its contribution to the efficiency and effectiveness of educational processes can be increased by focusing on the idea of knowledge transformation. Knowledge transformation refers to an issue otherwise known as knowledge use, knowledge transfer, or knowledge application. The necessary conditions for productive knowledge transformation are as follows: a knowledge base; a problem definition related to the base; transformation/learning strategies involving various modes of representing "old" knowledge as well as acquisition of "new" knowledge; and appropriate motivation. To transform this general model to pedagogic research and the advancement of pedagogy, it is necessary to develop a model of the context of pedagogy. Teachers must transform research findings into on-site solutions in interaction with extant knowledge bases, professional expertise, and operating systems involving regulatory and accountability procedures. Education research should be designed and managed by teams containing cadres of educational workers with a shared commitment to following research through to action. Moreover, greater investment in urgency in educational research and in the learning process called transformation is needed. (MN)

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Putting educational research to use through knowledge transformation

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Feedback should be sent to
Information Services,
Learning and Skills Development Agency,
3 Citadel Place, Tinworth Street, London SE11 5EF
Tel 020 7962 1066 Fax 020 7962 1258
enquiries@LSagency.org.uk

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Note
The Learning and Skills Development Agency was formerly known as FEDA.

Further information
For further information on the issues discussed in this publication please contact:
John Vorhaus, Development Adviser,
Learning and Skills Development Agency,
3 Citadel Place, Tinworth Street, London SE11 5EF.
Tel 020 7840 5443
jvorhaus@LSagency.org.uk

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Preface

Educational research, like education itself, is facing unprecedented demands for change. Reports including the Ofsted survey of educational research (Tooley and Darby 1998) and leading academics such as David Hargreaves and Richard Pring (eg Hargreaves 1996) have independently arrived at two common conclusions: first, that too much research to date remains either irrelevant or arcane, and second, that the primary purpose of research should be to promote the efficiency and effectiveness of educational processes. At the same time, it is widely recognised that the area of post-16 education is under-researched (eg Desforges 1999) and that there is a pressing need to expand the evidence base for policy and practice.

Professor Charles Desforges is a prominent and highly influential advocate for more, and more relevant, research. He is also the director of the Teaching and Learning Research Programme, an ongoing £12.5m programme of research into teaching and learning in the UK, commissioned by the Economic and Social Research Council.

The Learning and Skills Development Agency invited Professor Desforges to give a keynote speech at the FERN conference in December 2000, which is presented in this report. Professor Desforges offers an original and important contribution to the question of how research can make a positive difference to policy and practice in post-16 education and training – a contribution which is warmly welcomed by the Agency.

These are exciting times for the Agency. Following a recent invitation by the DfEE to develop research capacity in the post-16 sector, it is proposed that we establish a research centre for learning and skills. The envisaged role of the Centre and the central themes emerging from Professor Desforges' paper are strikingly congruent. Both emphasise:

- evidence-informed policy and practice
- research capacity building
- practitioner involvement
- the importance of 'impact' on policy and practice
- the transformation of research findings into developmental activity and improved practice.

It is the last three points that are most prominent in Professor Desforges lecture presented here. Desforges conceives educational research as a 'service industry for education', and the moral objective of education as 'help[ing] people make the best of themselves through the processes of learning'. He argues that if we want to promote the impact of educational research we need to give thought to the idea of *knowledge transformation* – a term which arises in response to the question: how can we best arrange what we as researchers have learned so that it is applicable, usable, or transferable to educational settings? We may know how to divide 225 by 15, but find ourselves stumped if asked how many of 225 flower bulbs we should put into each of 15 flower beds, assuming an equal distribution of bulbs. The problem in this case, as Desforges explains, is that the relevance of our computational knowledge is lost on us – and the challenge that faces the research community is to understand how we can transform or make use of the knowledge we already have in order to answer such questions. Nor is it simply a matter of transferring existing knowledge to a new problem; rather, we need to learn how to draw on 'old knowledge in a particular problem context to engage in new learning towards a problem solution'.

The idea of 'knowledge transformation', the involvement of practitioners and the focus on relevance and impact are just some of the features highlighted in the lecture presented here. You don't have to agree with every word – nor is this what Professor Desforges would expect – in order to conclude that what he has to say is valuable and important: for post-16 educational research; for the work of the Agency and its research agenda in particular; and above all for educational practice, which for too long has been less involved with research effort, and on the receiving end of fewer research-driven benefits, than it is entitled to expect.

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Introduction

It is commonplace to observe that we live in a period of rapid and ever accelerating change. At the heart of the pace of change are multiple and continuous revolutions in the speed of information processing. Related developments in the globalisation of markets place us in an era of great promise of undreamt of opportunity. At the same time we are in an age of great threat as the forces of change stretch and tear at the established order of things.

If we are to prosper in these times we must learn not only to adapt rapidly to change but to capitalise on possibilities through the creation of new bodies of knowledge and wisdom. Learning, in this profound sense, is the core concept of our time. This realisation places massive demands on all educational providers to enhance their efficiency and effectiveness. Good teaching, broadly conceived, was always a most difficult task. It is ever more so. Increasingly, there is an expectation that educational policies and practices be informed by research.

From my point of view, educational research is a very distinctive form of inquiry. It shares the moral objective of education, which is to help people make the best of themselves through the processes of learning. If research is not intended to contribute to this purpose then, whatever else it is, it is not educational. Educational research is a service industry for education.

Sadly, a great deal of educational research (ie research that is intended to make a contribution to the efficiency and effectiveness of educational processes) has no such impact. In this talk I intend to advance thinking on how impact can be increased by focusing on the idea of *knowledge transformation*. Thinking about the impact of educational research is not a green-field site. Views and opinions abound. These often start from a condemnation of researchers or teachers or both.

To paraphrase this 'blame' position it has been said that 'researchers are lost in thought while teachers are missing in action'. I contend that this is not so much a paraphrase as a caricature of the situation. It is not my starting point.

Rather, my starting point is that the acquisition of safe knowledge (ie research) and its practical utilisation (ie professional work) are extremely difficult processes in every field. It has been well said that the medical profession took 300 years to learn to wash its hands and that sepsis is still the main killer in hospitals.

The comments I make address what I take to be a complex problem. They have significant practical implications for all those who want to contribute to the advancement of teaching and learning on the basis of systematic inquiry, whether they wish to categorise themselves as researchers, teachers or users of research. I base my analysis on the metaphor of knowledge transformation.

Knowledge transformation

Knowledge transformation refers to an issue otherwise known as knowledge use or knowledge transfer or knowledge application. Each of these four terms (use, transfer, application, transformation) has very powerful metaphoric force. I have discussed the theoretical origins and associations of these metaphors elsewhere (Desforges 2000). The challenge each metaphor represents runs something like this: how is knowledge acquired in one setting best profited from in problem-solving in another setting (yet another metaphor)? The settings may be theory into practice or one institution into another institution and so on.

I have recognised elsewhere (Desforges 2000) that some see this question as the greatest challenge facing research on teaching and learning while others see it as the greatest distraction. What is for sure is that the challenge to hand is part of the more general issue of 'impact'. What we learn must be arranged to be applicable/usable/transferable etc to settings other than our samples. How best to do this? How best to think about and hence prepare for this?

We have to sort some ideas out now because the problem definition has implications for what we 'do Monday'. We cannot stick with the traditional methods of working for impact because it is obvious that these have not worked.

This is a difficult challenge. The processes of knowledge transformation are not at all well understood. In this paper I offer an initial analysis of some of the facets of the matter. I expect and anticipate some debate on the particularities of the view I offer. What cannot be avoided by any of us, however, is the core objective of achieving general impact for research findings.

Facets of knowledge transformation

In the section that follows, I take, for illustrative purposes, some examples of knowledge transformation. I comment on them as a route to getting a better feel for what is involved.

Example 1

In the 11+ test we used to pester children with problems of the following type: 'If Alice is taller than Ben and Ben is taller than Colin, who is the taller, Colin or Alice?' This can be solved using the logic of 'transitive inference', which involves the propositions:

if A > B
and B > C
then A > C

Whatever the absolute measure of A or B or C, it turns out that people do not use a logical form to consider this sort of problem. Rather, they take the verbal propositions and transform them into a picture of three people. They then answer the question by reading out, as it were, from the mind's eye.

We can say that the verbal propositions are transformed into an alternative representation in order to facilitate a solution. Changing the mode of representation of knowledge to solve a problem to hand is a common form of knowledge transformation.

Example 2

I take this example from the world of material technology. In the 1950s the fish preservation industry was developing a number of techniques for the more economic and efficient long-term storage of that rapidly perishable foodstuff. In particular, the ancient craft of fish smoking was dying out and was in need of rethinking. The traditional process involved hanging fish on tenterhooks in a chimney for hours over a carefully tended, slowly smouldering bed of sawdust. A good cure involved burning the sawdust at just the right temperature to generate the appropriate tars and phenols. The technique was slow, uneconomic, weather dependent and unable to meet the demands of a mass market. Attempts were being made to mechanise the process. The key challenge was to 'cook' the sawdust at the right rate. A great deal of knowledge was to hand on how to cook solids. The coal industry had been doing it for decades.

The technique was, effectively, to turn the solid (coal) into a fine powder and then stir it by keeping it in an enclosed space (a tube) and blowing air through it. To all intents and purposes the solid coal had been converted into a liquid in a process called fluidisation. Effectively, the coal could be heated uniformly using heating elements in the surface of the tube. It was the corpus of knowledge and experience in the fluidisation of coal that chemical engineers turned to for the treatment of sawdust.

It did not work. At useful temperatures, sawdust is damp and particles clog. Blowing air into smouldering sawdust caused conflagration. Plenty was known about fluidisation – so much so that the problem of smoking sawdust was represented in these terms – but not enough was known about the particular material or the specific problem parameters to afford a simple 'transfer' of knowledge. The core knowledge of fluidisation had to be supplemented by and integrated into additional knowledge of scientific, engineering and economic forms.

Knowledge transformation can be seen to be a knowledge-led, problem-constrained learning process aimed at solving problems to hand.

Some things are known about the conditions which favour scientific/technological knowledge transformations which are worth logging here. In a recent history of the Industrial Revolution (Dugan and Dugan 2000) it has been argued that much of the scientific and engineering knowledge that was involved in the rise of mechanisation had been known for hundreds and in some cases thousands of years, but the circumstances for the mutual transformation of science and technology had not been favourable. It is argued by Dugan and Dugan (2000) that the development of advanced practices involving material technologies requires, at least:

- good science (ie a corpus of safe knowledge)
- good engineering
- good links between money and ideas
- liberal accountability regimes
- competition
- a market for effective ideas.

All these conditions obtained in Great Britain at the advent of the Industrial Revolution. I shall return to these facets of knowledge transformation later.

Example 3

This example comes from the field of teaching and learning. It is a startling success story offered by Brown (1983) and it refers to the challenge of learning to ski. In the early 1960s skiing was beginning to develop into a popular sport. The potential for a mass market was evident, but several problems stood in the way. There was a very large incidence of accidents and physical damage among learners. Ninety-five per cent of people taking skiing holidays did not return for a second attempt to learn. There were very low levels of attainment. It took several years for hardy and persistent souls to learn to ski proficiently.

By the mid-1980s all this had changed. Accidents were rare. Repeat bookings were the norm. Proficiency was acquired in months rather than years. These advances had been brought about by developments in both technology and pedagogy in mutual interaction. Tows and lifts replaced laborious climbs to good starting points. Advances in the design of ski boots afforded both more comfort and control and more safety through snap-off devices. Graduated ski lengths allowed beginners to start on short, more controllable skis and work up to longer, more speed-efficient ones. Heavy snow-moving, snow-creating machinery allowed the design of carefully graded nursery slopes.

These developments in technology were, at root, driven by market forces – the determination to mass market skiing. More proximally, they were driven by pedagogy – the requirement to afford more practice of a safe and graded form. The graduated ski length in particular allowed learners to take on the whole task of ski trailing. This allows subskills to be practised in 'real' skiing, which in turn keeps motivation high. The developments, taken collectively, afforded the capacity to keep the learner enduringly and safely practising at the limits of competence.

No new science was involved in these developments. All the principles of engineering and of pedagogy were well established at the outset. What was involved was the mutual transformations of available knowledge as pedagogy made demands on engineering and engineering afforded opportunities for advanced pedagogy. Of course, market forces (including the profit motive and competition) played a significant part, as did health and safety regulations.

Example 4

I have chosen this example to focus on the individual learner. It is a common observation that learners have very great trouble using their knowledge to solve problems. An Assessment of Performance Unit (APU) survey of the mathematics attainment of 12 year olds in the UK (conducted in the early 1980s) showed that 80 per cent could calculate '225 divided by 15'. Only approximately 30 per cent of the same sample could solve the problem: 'A gardener has 225 flower bulbs to be put equally into each of 15 flower beds. How many must be put in each bed?' Follow-up interviews showed that students understood all the terms of the problem, but they did not know what sort of calculation was called for. The relevance of their computational knowledge was lost on them.

The failure to solve problems using pertinent knowledge is an exceedingly common phenomenon in educational settings and beyond. Getting learners to enhance their problem-solving capabilities through deploying their knowledge is a ubiquitous, and ubiquitously failed, educational challenge. Something is known about why people fail in this respect (Desforges 1996).

The most basic cause of failure is that the knowledge which is expected to be called on is not 'there'. The student has not learned that which has been taught. More commonly, pertinent knowledge has been acquired but its relevance to the problem in hand is not evident. The APU example is a case in point.

Not unusually, pertinent knowledge comes to mind and its relevance is clearly seen, but its deployment does not immediately lead to a solution. The example of fluidising sawdust illustrates this case. Problem solution requires a strategy for handling this situation. The strategy involves supplementing and/or transforming the knowledge base and is often called (sadly for this exposition) an 'applications strategy'. I shall here call it a 'transformation strategy'. Learners frequently fail to solve problems because they lack such a strategy. They do not know what to do when they do not know what to do.

Solving problems is not a matter merely of knowledge and intellect. Powerful emotional and motivational forces are at work and knowledge transformation is frequently frustrated because appropriate motivational forces do not operate or, indeed, countervailing forces obtain. In schools, children are often defeated by a fear of failure rather than a lack of knowledge. We have seen how market forces drove knowledge transformations in the skiing holiday and food preservation industries.

In summary, it is well established at the level of individual learners that there are four broad reasons accounting for the failure of knowledge transformation in pursuit of problem-solving. These are:

- relevant knowledge has not been acquired
- the relevance of acquired knowledge is not evident
- a transformation strategy is not available
- the 'learner' is not appropriately motivated.

Arguing by illustration I have suggested that what we know about knowledge at a systems level is isomorphic with what we know at the level of the individual. *Knowledge transformation* is not a simple act of 'use' or 'transfer' or 'application'. Rather, *it is a knowledge-led, problem-constrained learning process*. It draws on 'old' knowledge in a particular problem context to engage in new learning towards a problem solution.

The necessary conditions for productive transformation are:

- a knowledge base
- a problem definition related to that base
- transformation/learning strategies involving various modes of representing 'old' knowledge as well as the acquisition of 'new' knowledge
- appropriate motivation.

To transform this general model to pedagogic research and the advancement of pedagogy it is necessary to set out a model of the context of pedagogy.

Advancing pedagogic practice through the transformation of research findings

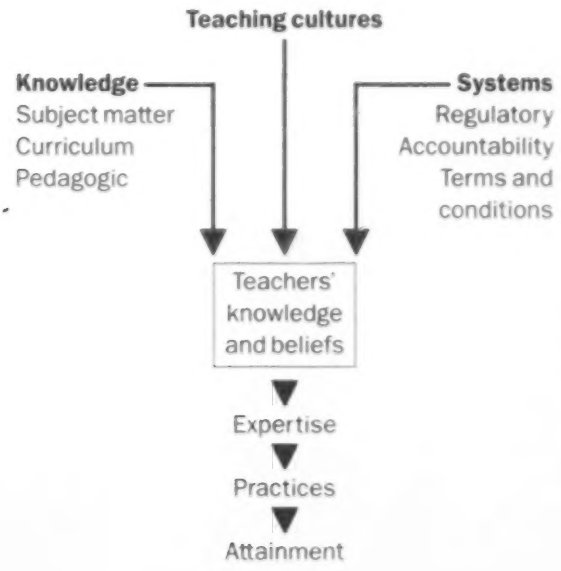
We have to face the question: 'how can our research findings be transformed into advanced educational practices which promote attainment more efficiently and effectively?' The question is made more pointed by the observation that the track record of impact in this sense is weak.

We must proceed by first being as explicit as possible about our position on knowledge transformation and integrating that with our best, most explicit understanding of the context in which transformation is expected to have its effects (ie the 'problem constraints').

The pedagogic context

Figure 1 shows a tentative model of the pedagogic context. Teachers' impact on attainment is mediated by their teaching practices broadly conceived. These in turn are mediated by teachers' expertise (wisdom, judgement, decision making), which relates their body of knowledge and beliefs relevant to teaching and learning to their appraisals of particular pedagogic settings. A teacher's corpus of pedagogic knowledge involves and includes their representation of curriculum-related knowledge, their understanding of the culture of their profession, and their appreciation of the regulatory and accountability systems in which they operate. There is an extensive literature on each of these, showing the effects on practice of teachers' levels of academic expertise (Turner-Bissett 1999), the influence of academic subject (departmental) cultures (Grossman and Stodolsky 1995) and the effects of assessment systems (Linn 2000).

FIGURE 1
The structure of teaching practices



Research knowledge about pedagogy may arise from and/or be brought to bear on any of the aspects of the pedagogic context but it will inevitably be interpreted in all of it.

This is not to say that all components are of equal power. There are some who argue that educational systems are run by accountability systems (Doyle 1983). In this view, regulatory and accountability systems swamp all other factors in determining practices (and hence the teacher's impact on student attainment). Whatever our judgement on the relative force or interactions of the factors in this model, they are part of the 'problem constraint' of bringing research findings to bear on attainment and they must, therefore, be considered in any attempt to transform research findings into advanced pedagogic practices.

The broad implications of this analysis are that research findings will be converted into action by teachers through the operation of their expertise within particular settings and systems. Notable among these are the regulatory and accountability systems. Our understanding of the development of material technologies suggests that the more rigorous these are the less room there is for experiment and the less call and opportunity there is for knowledge transformation. The same can be implied for 'human' technologies in the shape of professional practices – assessment systems drive educational systems. The higher the stakes, in terms of accountability, the more these strictures obtain and the more narrow and conservative is the response to calls for change.

If research is to feed into advanced practices then findings must have something to say about assessment and curriculum processes and systems. In order to achieve the objective of raising attainment, we can anticipate that research findings will have to be transformed into practical implications for teachers' operating systems and cultures as well as teachers' practices.

Teachers' knowledge representation

A further dimension of the problem constraints on the transformation of research knowledge for advancing practices arises from the consideration that practitioners already have an established knowledge base relevant to teaching.

Any new knowledge will be assimilated to and accommodated by the extant knowledge base. Attempts at appropriate knowledge transformation must proceed in the light of our best understanding of the ways in which teachers organise and represent professionally relevant knowledge and in consideration of how 'new' knowledge interacts with 'old' knowledge in learning situations structured by practice.

Shulman's work is seminal here in regard to knowledge representation. Shulman suggested that teachers hold three broad 'forms' of knowledge, namely propositional knowledge, case knowledge and strategic knowledge. Propositional knowledge is represented in the form of statements of, for example, 'what works' or 'what to do'. Propositions might draw on research (eg 'distributed practice is better than mass practice'). Equally they might represent 'experience' or 'folk-lore' (eg 'never smile before Christmas'). Knowledge stored as propositions is associated with a number of limitations. First, it would take an infinite number of propositions to meet the myriad circumstances of teaching. At the very least, such a set would be difficult to remember and access according to need. Second, propositional knowledge is very difficult to contextualise. How is one, for example, to 'treat each child as an individual' or 'teach for understanding' in a given circumstance? Third, propositions often contradict each other: for example 'waiting for answers to questions allows time for deeper thought' but 'delays in action disrupt the flow of lessons and threaten classroom order'.

'Case knowledge' is a way of chunking, through transformation, professional knowledge. A 'case' is an example of an 'event set' (eg 'a difficult class', 'a special needs learner'). Case knowledge theorises the basic description of an exemplar event and to that degree represents it at a first level of abstraction. A case is represented as narrative affording a more complex, multidimensional story to guide practice.

'Strategic knowledge' is a form of wisdom or judgement. It is particularly relevant to dealing with new or conflicting situations (eg what to do when propositions on 'waiting' contradict propositions on 'lesson flow').

This is not the place for a detailed exposition and critique of Shulman's work. My point here is that we will need some form of conceptual position and understanding on how practitioners represent pedagogic knowledge if we are to play a role in transforming it through research findings. For my part I find Shulman's work analytically rich but pragmatically Gothic. It seems strong on conception but weak on usability.

Running summary

It is my fond hope that the argument in this paper will be taken at the strategic rather than the detailed level. Nothing of the detail is significant. It really does not matter, for example, whether or not you agree with Shulman, or whether or not you agree with a particular formulation of a problem.

The key strategic argument is:

- educational research is committed to learning lessons which will help to enhance attainment system-wide
- research findings cannot do that any more than Newton's laws can get a rocket to the moon
- findings must be transformed into on-site solutions in interaction with:
  - extant knowledge bases
  - professional expertise
  - operating systems (most notably those involving regulatory and accountability procedures).

In particular, these involve the system constraints on the practice of teaching and the constraints offered by teachers' existing knowledge bases.

We must be in a position to speak to system regulators as well as system operators or we will, at best, be marginalised in the knowledge economy.

Finally, I have argued that competition is a good thing in the context of knowledge transformation. In this regard some competition between research paradigms is to be welcomed. The prize, though, will not go to whoever says most words but to those who most advance and enrich attainment.

Implications for the conduct and management of educational research

I started with the view that educational research is a special form of inquiry arising from the nature of education. Education has a moral imperative to enhance human potential through learning. Educational research must share that commitment. It is a service industry to education.

I argued that educational research findings often fail to have an impact on educational provision and suggested we re-think 'impact' in terms of the metaphor of 'knowledge transformation'. Knowledge transformation is knowledge led. We already know something about teaching and learning.

The first implication of my argument is that we should recognise that we know something. There is far too much determinedly 'green-field' work on 'brown-field' sites. We know, for example, that the characteristics of good learning environments are:

- learner centred
- knowledge centred
- assessment centred
- community centred (Bransford et al 1999).

A vaunting research agenda flows directly from that platform in terms of understanding why particular learning environments fall short of that specification and what needs to be done to move them towards it.

The second implication of the transformation metaphor is that educational research should be designed and managed by teams containing all cadres of educational workers (tutors, managers, policy-makers) with a shared commitment to following research through to action. There may of necessity be specialisation of function but there must be generality of management and design. The distinction between 'researcher' and 'user' is not profitable in education.

Third, there must be greater investment in urgency in research in education. If the pace of social change is even one-tenth of what it is claimed to be, there is no general place for the 2 year commissioning, 6 year project.

Fourth, there must be greater investment from the start of a research programme in the learning process called transformation. Transformation is not the 'D' of R&D. It is the 'R' of research in *education*. It is a bona fide research process of systematic inquiry for progressive practice at all levels in the system. The commitment to impact must be evident, from day one, in the practical conduct of the research.

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Charles Desforges is a prominent and highly influential advocate for more, and more relevant, educational research. In his keynote speech at the FERN conference of December 2000, presented in this publication, he argues that in order to promote the impact of educational research we need to consider above all the role and significance of 'knowledge transformation'. Desforges maintains that practitioners should be far more involved in research than they are at present, and underlines the need for research findings to have a positive impact on practice. You may not agree with everything he says, but Desforges' lecture is an important and stimulating contribution to the question of how we think about the role of educational research today.

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